Nuclear INFORMATION

Greater St. Louis Citizens' COMMITTEE FOR NUCLEAR INFORMATION

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# STRONTIUM 90 AND COMMON FOODS

MUCH has been written and discussed during the past several years about the strontium 90 (Sr 90) content of milk resulting from radioactive fallout, but the public has heard little about radioactivity in other foods. The extent of the latter problem has been pointed up recently by a series of newspaper reports dealing with the Sr 90 content of Minnesota wheat.

ON FEB. 6, 1959, Dr. Maurice Visscher, head of the Department of Physiology, University of Minnesota School of Medicine, and a key member of Minnesota Governor Orville L.. Freeman's Atomic Development Problems Committee, issued a statement based on a three-year wheat survey. The statement pointed out that the average Sr 90 content of 23 samples of wheat from North and South Dakota and Minnesota was about one and one-half times as great as the AEC's own safe limit for human consumption (see below).

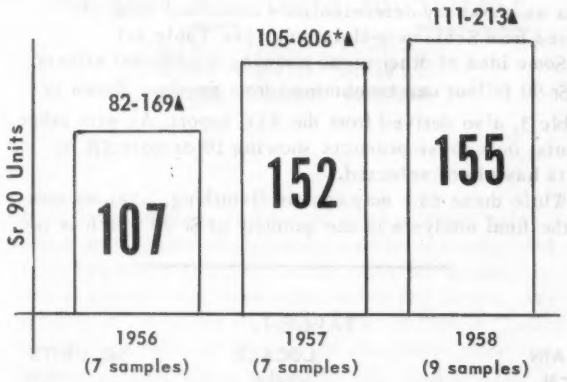
In a subsequent newspaper statement carrying a February 25 Washington date-line, Dr. Charles Dunham, head of the AEC's Division of Biology and Medicine, confirmed the fact that the AEC, at the request of Minnesota state officials, had indeed analyzed 23 samples of Minnesota wheat for Sr 90 content. Dr. Dunham was further quoted as saying that ". . . there is no reason to think that anyone is getting excessive amounts of strontium in his diet" from wheat or any other food source.

We have attempted here to evaluate the extent of this problem, utilizing two sources of readily available data: (1) A copy of Dr. Visscher's report which he was kind enough to send us, and (2) Data extracted from Tables 13 and 14 of the February 24 Strontium Program Quarterly Summary Report issued by the Health and Safety Laboratory of the New York Operations Office of the AEC. In giving permission to cite the latter data, Dr. S. Allen Lough, Director of the New York Office stated that this report would shortly be released for purchase.

### Wheat and Rye Rich in Sr 90

A summary of the AEC's findings on Sr 90 content of wheat derived from Dr. Visscher's statement appears in the chart. The latter report considers 100 Sr 90 units (i.e., 100 micromicrocuries per gram of calcium) in the diet as the maximum tolerable level for Sr 90 in food. The report further points out that anyone who would derive all of his calcium from whole wheat of the type analyzed would exceed the maximum tolerable limts. Fortunately, however, a major part of the calcium and, therefore, the Sr 90, is in the bran and is milled out of white flour. Some idea of the loss of radioactivity in the milling process can be obtained from the data in Table 1, derived from Tables 13 and 14 of the AEC report. Here it is evident that the bran of a mixed sample of wheat has an Sr 90 unit value of 80, while the refined flour contains only 31 units. In the case of a mixed sample of rye there is a similar relationship, with bran containing 100 Sr 90

CHART




▲ Show range of variation.
★ Excluded from averages.

units while the refined flour contains only 20. Judging from these samples one might estimate that refined flour contains roughly 15-30 per cent the radioactivity of the bran. In the instance of these samples the refined flour has an Sr 90 content already exceeding that for milk in the St. Louis area (15.4 as of September 1958) and equal to about 20-30 per cent of the maximum tolerable level.

The AEC report contains 30 determinations on grain samples; the 18 figures shown in Table 1 represent those samples showing 10 or more Sr 90 units. Four of these are at or above the estimate of the maximum tolerable level of 100 and several others approach this level.

### Vegetables Have Sr 90 Too

Nor is the problem as regards plant life limited to grains. The information available in the AEC report indicates that Germany, in particular Schleswig-Holstein, has relatively high radioactivity in a number of produce items. Thus, a sample of potatoes has shown 40 Sr 90 units, kale 12, onion 30, lettuce 24 and 20, turnips 13, the edible portion of cauliflower 20, asparagus stalks 45, tomatoes 80. A sample of grass from Kiel contained 38 Sr 90 units. In some instances, at least, this high content in grass is reflected in the animal life of the

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Editor: Dr. Florence Moog, Associate Editor: Marion Mathews.

Editorial Board: Drs. Walter Baumgarten, Jr., H.T. Blumenthal, Edward M. Brooks, Barry Commoner, John M. Fowler, Irwin H. Herskowitz, Miriam Pennoyer.

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area as shown by determinations on animal bone obtained from Schleswig-Holstein. (See Table 2.)

Some idea of other areas showing significant effects of Sr 90 fallout can be obtained from the data shown in Table 3, also derived from the AEC report. As with other plants, only those products showing 10 or more SR 90 units have been selected.

While these data may appear disturbing, what matters in the final analysis is the quantity of Sr 90 which is retained in the body, where it replaces calcium. Before this can be determined with any certainty many factors have to be considered. Certain of the latter relate to the utilization of calcium, since the body utilizes Sr 90 in identical fashion to calcium.

TABLE 1.

| GRAIN | LOCALE | SR. UNITS |
|---|---|---|
| Wheat | Alaska | 100 |
| Wheat flour | Chile | 86 |
| Wheat bran | USA-Germany Mixed | 80 |
| Wheat flour (low grade) | USA-Germany Mixed | 80 |
| Wheat flour (secondary) | USA-Germany Mixed | 37 |
| Wheat flour | USA-Germany Mixed | 31 |
| Rye | Amrum | 128 |
| Rye whole grain | Mixed Germany Import | 30 |
| Rye bran | Mixed Germany Import | 100 |
| Rye flour (low grade) | Mixed Germany Import | 57 |
| Rye flour | Mixed Germany Import | 20 |
| Oat flour | Not designated | 34 |
| Oats | Not designated | 10 |
| Oats | Schleswig-Holstein | 15 |
| Barley | Schleswig-Holstein | 70 |
| Barley | Syria | 10 |
| Corn | Africa | 44 |
| Rice with hulls | Ceylon | 150 |

### How much calcium do we need?

Calcium is an indispensable mineral; it is a constituent of all animal fluids and solid tissues. It constitutes about 50 per cent of the minerals in bones, and about 99 per cent of the total quantity of calcium in the adult human is contained in the skeleton. The calcium is deposited during the latter part of fetal life, and its deposition increases progressively until the cessation of skeletal growth at about 18-20 years of age. The breast-fed infant is adequately maintained on about .45 mg. per Kg. daily, and the artifically fed infant on about three times that amount. While the requirement related to body weight is greatest in early infancy, the total quantity required daily increases through adolescence. Thus the minimum calcium requirement between 6 months and 2 years of age is about 0.8 gm., between 2 and 9 years 0.9 gm., between 9 and 15 years 1 gram, increasing progressively to 2 grams,

TABLE 2.

| ORIGIN | SR. UNITS |
|---|---|
| Hogs | 1.6 |
| Ox | 3.6 |
| Goose | 4.8 |
| Seal | less than 0.1 |
| Hare | 10.0 |
| Deer, male | 65.0 |
| Deer, female | 9.0 |
| Horse | 4.6 |
| Lamb | 4.7 |
| Calf | 1.0 |

and from 15 years to adulthood a progressive decrease to .55 gm. There is an increased requirement in the adult during pregnancy to 1.5 to 2 gm. in order to provide for the skeletal development of the fetus, and an increased local requirement in the event of fractures of bone to provide for healing.

Milk and other dairy products constitute the most important and best natural source of calcium, and it has been estimated that they provide about three-quarters of the calcium in the average American diet. Fruits and vegetables, including cereals, furnish the remaining quarter. Meat is a poor source of calcium. Judging from studies in the rat the calcium of many vegetables is well utilized. The exceptions to this are spinach and other leafy vegetables containing oxalate, which prevents the absorption of calcium. As for cereals such as wheat and oatmeal, the presence of phytic acid, which combines with calcium to form an insoluble salt, also prevents absorption. Whole wheat flour has a higher phytic acid content than white flour. Much of the calcium in

TABLE 3.

| LOCALE | PRODUCT | SR. UNITS |
|---|---|---|
| Chile | Potatoes | 23.73 |
| Siam | Lettuce | 10.0 |
| Holland | Green peas | 50.0 |
| Spain | Oranges | 10.0 |
| South Africa | Candied Fruit | 10.0 |
| Jungfern Island | Grass | 11.0 |
| China | Ground nuts | 60.0 |
| | Bitter almond nuts | 14.0 |
| | Ginger | 60.0 |
| | Cinnamon | 85.0 |
| Norway | Cheese | 11.5 |
| India | Cheese | 13.0 |

*(Continued on back page)*

# BABY TOOTH SURVEY IS ON ITS WAY

THE DECEMBER issue of *Information* was devoted to launching the Baby Tooth Survey, a plan to collect 50,000 baby teeth a year for study of strontium 90 deposition. The idea of using baby teeth for this purpose has been suggested numerous times, and was called to the attention of CNI by our vice-president Dr. Alfred S. Schwartz, who is a pediatrician. The enthusiastic response to Dr. Schwartz's proposal led to the setting up of a large-scale program for collecting and analyzing milk teeth. The Survey is believed to be the only operation of its kind anywhere in the world.

Baby teeth are of great value, for two reasons. For one thing, they represent the only strontium-rich human tissue that is readily available in steady supply. Secondly, they acquire the major part of their mineral content during a short period before and after birth, and so they are expected to reflect the rate of deposition of strontium during a limited period of time. The teeth coming in now, from youngsters 5 to 10 years old, will show the rate of uptake in the early years of the present decade, when the strontium 90 content of milk and other foods was relatively low. It is important to get the study into full operation as soon as possible, so that scientists can establish the rate of uptake at the beginning of the atomic era. The results will provide a base line for evaluating the increases that are expected to follow from the continued testing of nuclear weapons.

### Scientific Advisory Committee Set Up

Under the vigorous leadership of Dr. Louise Reiss, St. Louis internist, the Baby Tooth Survey has been making rapid progress. Early in February a Scientific Advisory Committee was formed to guide the work. Under the chairmanship of Dr. John T. Bird, Jr., Associate Professor of Dental Medicine and Assistant Dean of the Washington University School of Dentistry, the Committee includes deans of both the St. Louis and Washington University Schools of Dentistry, respectively Drs. Stephen Forrest and Leroy Boling; Dr. E. A. Khalifah, Editor of the Journal of the Missouri State Dental Association; Dr. Philip Vierheller, President of the St. Louis Dental Society and of the Missouri State Board of Dental Examiners; Dr. Donald Flieder, Associate Professor of Dental Pathology at St. Louis U.; Dr. John Gilster, Associate Professor of Dental Pediatrics, and Dr. Harold Rosenthal, Assistant Professor of Biochemistry, both of Washington U. Dr. Gilster is also Editor of the Bulletin of the St. Louis Dental Society. Others on the Committee are Drs. Barry Commoner, Eric Reiss, and Alfred S. Schwartz, all of Washington University, and Dr. Louise Reiss.

### The Teeth Are Pouring In

The first month of the survey brought in over 1000 teeth from the local area, and by the middle of March over 3000 had been received. Local dentists, schools,

**LOOK MA-
NO TEETH!**

He gave HIS teeth to SCIENCE

BABY TOOTH SURVEY

churches, libraries, and social organizations have taken up the work of collection enthusiastically, and teeth are now pouring in. Teeth extracted in the city dental clinics have been promised to the Survey. According to Dr. Ozias Pacquin, Chief of Dental Clinics of the Department of Health and Hospitals, more than 14,000 teeth are extracted in the city clinics each year. The widespread publicity the Survey is receiving has brought in teeth from places as far away as Hawaii and Spain. Recently the committee received the tooth of a 10-year old girl in Calcutta, India, whose father had read about the Survey in a Calcutta paper.

The analysis of thousands of teeth is a tremendous job. It is estimated that $250,000 will be needed to finance the project for the 5-year term now planned, and a grant is being requested from the National Institute of Dental Research, a unit of the National Institutes of Health in Bethesda, Md. If the grant is received, it will be used to establish a laboratory at the Washington U. School of Dentistry to carry out the work. In addition to measuring the amount of radioactivity being absorbed by the children of the St. Louis area, such a laboratory would also be able to perform important basic studies on the structure and formation of teeth.

Pending establishment of the new laboratory, Dr. John Gilster has already laid out a program for cataloguing the teeth as to time of development and environmental background. This work is being carried out at St. Louis and Washington Universities. No analytical results are available yet, but *Information* will keep its readers abreast of developments as they occur.

To be useful, teeth submitted to the Survey must be accompanied by specific information. Forms which a parent can fill out may be obtained from many dentists, or by calling the Baby Tooth Survey, JE 3-0353, from 9 a.m. to noon. F.M.

# How does Strontium 90 Get into Plants?

PLANTS, especially grass, are a vital link in the food chain that brings strontium 90, deposited by fallout, into the human diet. The amount of strontium 90 that appears in milk depends on how much of the fallout material is picked up by the plants that are used for fodder.

Until recently it was assumed that strontium 90 would fall on the earth, enter the soil, and be absorbed by plants through the roots. Since experiments showed that roots would reject a part of the strontium 90 in the soil, root absorption is a helpful protective step in the food chain.

### Stem-Base Absorption

Now, from a recent study reported by Dr. R.D. Russell of the British Agricultural Research Council Radiobiological Laboratory (in the journal *Nature*, Sept. 27, 1958), it appears that grass plants do not always pick up strontium 90 by means of root absorption. Instead, Russell finds, strontium 90 in rain falls on grass leaves and accumulates at the joint between the leaf-base and the stem. From this point the strontium 90 is efficiently absorbed.

Unlike root absorption, stem-base absorption fails to discriminate against strontium 90. Russell finds that in English pastures about 80 per cent of the strontium 90 that eventually gets into milk enters grass via the stem-base route, rather than through the soil and roots. As a result, he finds that milk contains 8 to 15 times more strontium 90 from fallout than was expected on the basis of the root absorption theory.

Russell suggests that the relative importance of different routes of strontium 90 absorption may vary from place to place depending on various growth factors such as the tightness of the turf. Comparison of pasture studies in England and New York indicate that stem-base absorption is more important in England.

### A Word of Caution

Stressing the lack of detailed knowledge about the exact path of strontium 90 absorption in various places, Russell cautions against generalizations. He believes that assumptions about the path of absorption cannot lead to successful predictions about the amounts of strontium 90 that will enter food and he concludes, "If long term predictions are to deserve credence, careful experimental work is necessary."

Current data on milk from different parts of the United States (see February issue, INFORMATION) shows considerable unexplained variation in strontium 90 levels. Russell's work shows that these differences may be due to differences in plant behavior that we have just begun to discover. B.C.

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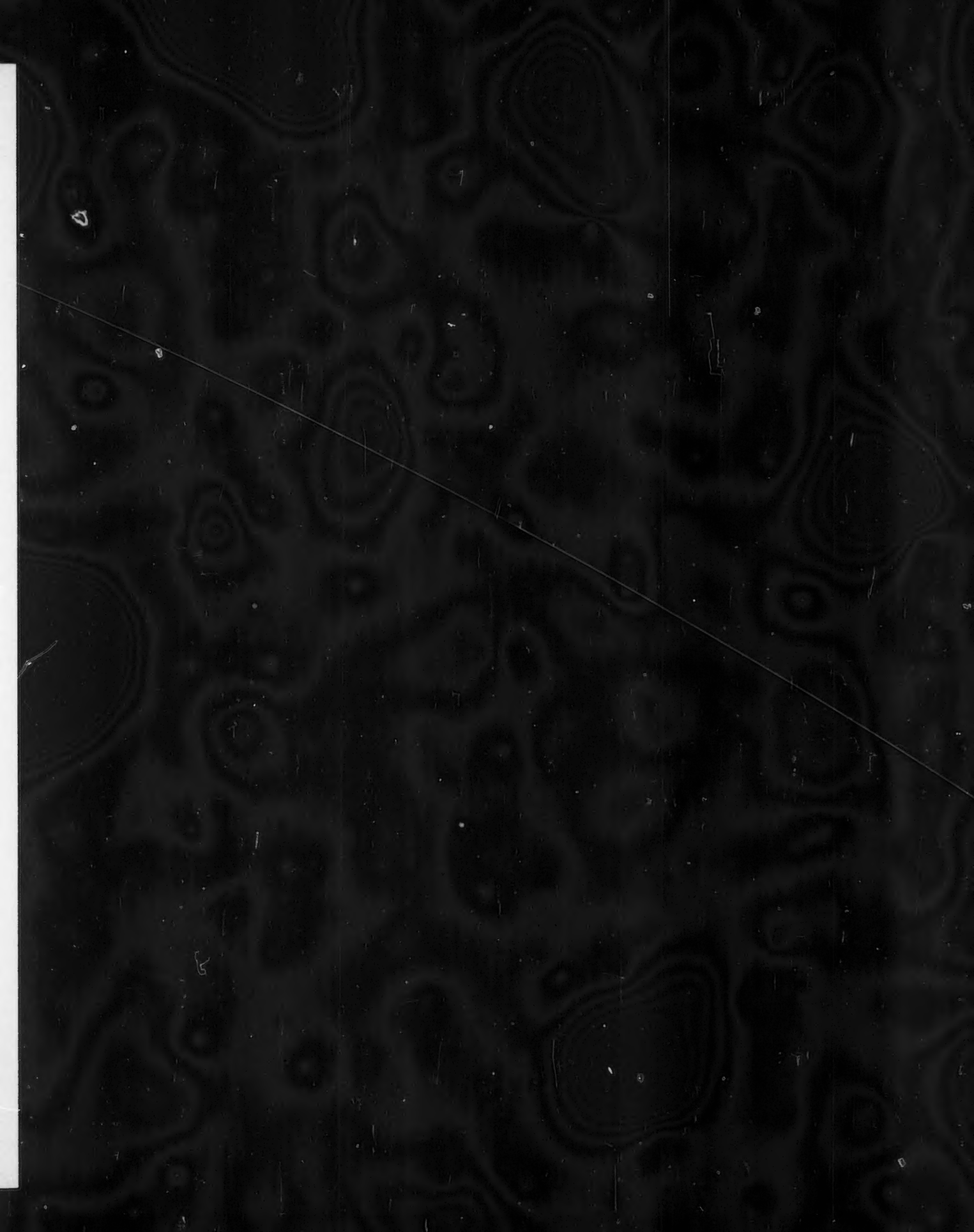
the white flour may be absorbed and utilized. Since the average Sr 90 content of the Minnesota wheat tested is even higher than that of the German-USA mixture shown in Table 1, one may assume that the white flour derived from Minnesota wheat would contain at least 31 Sr 90 units or roughly about twice as much per gram of calcium as the 15.4 reading obtained for St. Louis milk in September 1958.

### How much calcium is utilized?

Another factor which must be taken into consideration is the body's utilization of the calcium taken in; the proportion of calcium so utilized varies with the age of the individual. Thus, children 3-13 years of age with a daily intake of .74 to 1.02 gm. retain and use about 20-60 per cent, depending upon the size of the child (the younger the child, the greater the per cent), while adults utilize only 15-20 per cent of their intake.

During infancy and childhood, milk and other dairy products provide almost all of the dietary calcium, and during this period of life the Sr 90 content of milk assumes a relatively greater importance than in adolescence and adulthood, when vegetables and cereals provide as much as about one-fourth of the requirement for calcium. Cereals alone have been estimated to provide 5-10 per cent of the daily calcium requirement.

If one accepts a daily calcium requirement (and intake) during adolescence and adult life of 0.5 to 1 gm., and assumes that 75 per cent of this is derived from milk and other dairy products, 10 per cent from cereals, and 15 per cent from vegetables and fruit, then the average daily radioactive intake derived from dairy sources (based on the Sr 90 figure of 15.4 for September 1958) comes to 5.78-11.55 micro-microcuries and from cereal (based on the Sr 90 figure for white flour in Table 1) comes to at least 1.55-3.10 micro-microcuries. Thus, without taking into consideration the possible Sr 90 content of fruits and vegetables, the daily dietary intake of Sr 90 may be estimated at between 7.33 and 14.65 Sr 90 units.

This would indeed be alarming if all of this radioactive material were to be deposited in bone. But only about 20 per cent of the calcium intake is utilized, and presumably this is also true for Sr 90. It is not yet known exactly what portion of the dietary Sr 90 is taken up by the body; as pointed out in the last issue of this bulletin, it may be as little as one-half or as much as all of the Sr 90 in the food. On the other hand, the Sr 90 level of food can be expected to rise two to three times the 1958 level in the next 10-15 years. Moreover, the maximum permissible concentration level of Sr 90 presently set may have to be modified as further knowledge is accumulated. Dr. Visscher's statement considers it to be 100 Sr 90 units, while the International Commission on Radiological Protection has set it at 80.

Caution must be exercised in drawing broad conclusions from the limited information currently available. On the other hand, we should also avoid being lulled into a false sense of security by statements tending to minimize the problem. It is abundantly evident that what is required is much more sampling and further careful evaluation of the data obtained. H.T.B.